2. BACKGROUND

2.1 Bay-Delta Problems/Objectives

There is a rich history of conflict over resource management in the Bay-Delta system. For decades the region has been the focus of competing interests--economic and ecological, urban and agricultural. These conflicting demands have resulted in several resource threats to the Bay-Delta: the decline of wildlife habitat; the threat of extinction of several native plant and animal species; the collapse of one of the richest commercial fisheries in the nation; the degradation of Delta water quality; the continued land subsidence on Delta islands; and a Delta levee system faced with a high risk of failure.

At the simplest level, problems occur when there is conflict over the use of resources from the Bay-Delta system. As water demands increase, California asks more of the system, and there is more conflict. Single-purpose efforts to solve problems often fail to address the conflict. To the extent that these efforts acquire or protect resources for one interest, they may cause impacts on other resources and increase the level of conflict. Major conflicts are summarized below.

- *Fisheries and Water Diversions.* The conflict between fisheries and water diversions results primarily from fish mortality attributable to water diversions. This includes direct loss at pumps, reduced survival when young fish are drawn out of river channels into the Delta, reduced spawning success of adults when migratory cues are altered, and reduced survival associated with inadequate stream flows and reduced Delta outflows. The need to protect listed species has prompted restrictions on pumping and other regulations, which restrict the quantity and timing of diversions.

- *Habitat and Land Use.* Habitat to support various life stages of aquatic and terrestrial plants and animals in the Bay-Delta has been lost because of conversion of that habitat to agricultural and urban uses. In addition, some habitat has been lost or adversely altered due to construction of flood control facilities and levees needed to protect developed land. Efforts to restore the habitat can also create conflict with existing uses, such as agriculture and levee maintenance.

- *Water Supply Availability and Other Beneficial Uses.* As water use and competition for water have increased during the past several decades, so has conflict among users. A major part of this conflict is between the volume of instream water needs and out-of-stream water needs, and the timing of those needs within the hydrologic cycle.

- *Water Quality and Human Activities.* Water quality for ecosystem and consumptive uses can be adversely affected by a broad range of human activities. In addition to particular activities that discharge pollutants (such as abandoned mines or industrial sources), urban and agricultural areas produce degraded surface runoff that can seriously affect the Bay-Delta's many beneficial uses.

From these central conflicts, CALFED identified a series of problems in each of four problem areas. From each problem, a program objective was developed. A complete set of identified problems and program objectives is contained in a publication entitled *Problem/Objective Definition*, March 1996. Copies are available from the CALFED Program office The four problem areas for the Bay-Delta system are:

Ecosystem Quality - The Bay-Delta system no longer provides the broad diversity of habitats nor the habitat quality necessary to maintain ecological functions and support healthy populations and communities of plants and animals. The health of the Bay-Delta ecosystem has declined in response to a loss of habitat to support various life stages of aquatic and terrestrial biota and a reduction in habitat quality due to several factors including diversion of water, toxics, and exotic species.

The primary ecosystem quality objective of the Program is to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta to support sustainable populations of diverse and valuable plant and animal species. A goal that follows from this primary objective is to achieve recovery of at-risk native species dependent on the Delta and Suisun Bay as the first step toward establishing large, self-sustaining populations of these species; support similar recovery of at-risk native species in San Francisco Bay and the watershed above the estuary; and minimize the need for future endangered species listings by reversing downward population trends of native species that are not listed. The strategy to achieve the objective and goals for ecosystem restoration is to begin recovery of ecosystem health by reducing or eliminating factors that degrade habitat, impair ecological functions, or reduce the population size or health of species.

Water Supply Reliability - During the past several decades, as water diversions and recognition of environmental water needs have both increased, conflicts between these water uses have also increased. In response to declining fish and wildlife populations, water flow and timing requirements have been established for certain fish and wildlife species. Over the past decade, a number of protective actions including the Central Valley Project Improvement Act and the Delta Accord have reduced the CVP and SWP ability to meet the water demand both in quantity and timing for exports from the Delta. Conflicts between protective environmental measures and Delta exports also reduce opportunities for market water transfers. There are concerns that additional restrictions that might be needed to protect species or for other regulatory purposes could increase the uncertainty of Delta water supplies which, in turn, have created economic uncertainty in the water service areas and increased conflict over supplies.

The primary water supply reliability objective of the Program is to reduce the mismatch between Bay-Delta water supplies and current and other projected beneficial uses dependent on the Bay-Delta system. The Program has a three-part strategy to improve water supply reliability:

- Increase the utility of available water supplies (making water suitable for more uses and reuses).
- Improve access to existing or new water supplies, in an economically efficient manner, for environmental, urban, and agricultural beneficial uses.
- Improve flexibility of managing water supply and demand in order to reduce conflicts between beneficial uses, improve access to water supplies, and decrease system vulnerability.

This strategy seeks to reduce the mismatch between supply and beneficial uses through a variety of actions including increasing the ability and flexibility to store and transport water, reducing the impact of water diversions on the Bay-Delta system, and managing demand by increasing water conservation and recycling and by better facilitating water transfer markets.

Water Quality - Bay-Delta water quality is a major concern. The Delta is a source of drinking water for millions of Californians and is critical to the state's agricultural sector. In addition, good water quality is required to maintain the high quality habitat needed in the Bay-Delta system to support a diversity of fish and wildlife populations.

The primary water quality objective of the Program is to provide good water quality for all beneficial uses. Good water quality means different things to different users, and there are different ways to achieve the objective. The Program's strategy to achieve the water quality objective includes a combination of measures including source reduction, alternative sources of water, treatment, and storage and conveyance improvements. Many of the Program's water quality sub-objectives concentrate on a direct source control approach.

Levee System Integrity - Settlers first constructed levees in the Sacramento-San Joaquin Delta during the late 1800s. Initially settlers built levees to turn swamp and overflow lands into agricultural land and over time increased the levee heights to maintain protection as both settling of levees and shallow subsidence of Delta island soils occurred (oxidation, peat fires, and wind erosion have lowered interior island elevations over time). The increased levee heights combined with poor levee construction, and inadequate levee maintenance makes Delta levees vulnerable to failure, especially during earthquakes or floods. Delta island farmland, residences, wildlife habitat, and critical infrastructure can be flooded as a result of a levee failure. Levee failure on specific Delta islands can have direct or indirect impacts on water supply distribution systems. Direct impacts result from flooding of distribution systems such as the Mokelumne Aqueduct, and indirect impacts result from salty water moving up into the Delta, as an island is inundated under non-flood conditions. The increased salinity in the Delta would be of particular concern in a low water year, when less freshwater would be available to flush out the salt water (such as occurred when the Brannan Andrus Island levee failed in 1972). Long-term flooding of specific Delta islands can have an effect on water quality by changing the rate and area of the mixing zone. A long interruption of water supply for in-Delta and export use by both urban and agricultural users could result, until the salt water could be flushed from the Delta.

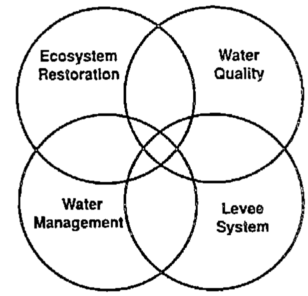
The primary levee system vulnerability objective of the Program is to reduce the risk to land use and associated economic activities, water supply, infrastructure, and the ecosystem from catastrophic breaching of Delta levees. Failure of Delta levees can result either from catastrophic events, such as earthquakes and floods, or from gradual deterioration. Subsidence of the Delta island peat soils and settling of levee foundations places additional pressure on levees and increases the risk of failure. The Program's strategy for achieving the levee system integrity objectives is to implement a comprehensive plan to address long-term levee stabilization and develop an effective emergency response capability in the event of failure while providing opportunities to maintain and enhance ecosystem values.

The unprecedented scope of the CALFED Bay-Delta Program cannot be overstated. The vast geographic extent of the area under consideration, the variety and complexity of the hydrological and ecological process involved, the history of conflict among the affected interests, and the magnitude of the potential economic consequences for California's commercial, agricultural, and industrial base all combine to make this effort the most ambitious of its kind anywhere in the world. In the United States, only the well-known efforts at addressing environmental and institutional problems in the Columbia River Basin, Chesapeake Bay, and in the Florida Everglades can serve as comparisons.

2.2 Fundamental Program Concepts

Three fundamental concepts related to the Bay-Delta system and its problems have guided the development of proposed CALFED solutions. These concepts are not new, but CALFED has looked at them in new ways to develop options for solving problems successfully.

First, the four problem areas (ecosystem quality, water quality, water supply reliability, and levee system integrity) are **interrelated**. CALFED cannot effectively describe problems in one problem area without discussing the other problem areas. It follows that solutions will be interrelated as well; many past attempts to improve a single problem area have achieved limited success because solutions were too narrowly focused.



Second, there is great variation in the flow of water through the system and in the demand for that water at any time scale that might be examined (from year to year, between seasons, even on a daily basis within a single season). The value of water for all uses tends to vary according to its scarcity, quality, and timing. This leads to the need for a water management strategy.

Finally, the solutions must be guided by **adaptive management**. The Bay-Delta system is exceedingly complex, and it is subject to constant change as a result of factors as diverse as global warming and the introduction of exotic species. CALFED will need to adaptively manage the system as we learn from our actions and as conditions change.

Interrelationships

In the past, most efforts to improve water supply reliability or water quality, improve ecosystem health, or maintain and improve Delta levees were single-purpose projects. A single purpose can keep the scope of a project manageable but may ultimately make the project more difficult to implement. The difficulty occurs because a project with narrow scope may help to solve a single problem but have impacts on other resources, causing other problems. This in turn leads to conflict. Ultimately, either no problem is solved, or one problem is solved while others are created.

Eight Program Elements Working Together to Solve the Four Problem Areas

- Long-Term Levee Protection Plan
- Water Quality Program
- Ecosystem Restoration Program
- Water Use Efficiency Program
- Water Transfer Program
- Watershed Program
- Storage
- Conveyance

The CALFED Program takes a different approach, recognizing that many of the problems in the Bay-Delta system are interrelated. Problems in any one problem area cannot be solved effectively without addressing problems in all four areas at once. This greatly increases the scope of our efforts but will ultimately enable us to make progress and move forward to a lasting solution.

Thus, the most important single difference between the CALFED Bay-Delta Program and past efforts to solve resource problems is the comprehensive nature of CALFED's interrelated resource management strategies. A comprehensive CALFED solution will also be supported by governance and finance mechanisms that overcome problem-specific or resource-specific limitations of previous, more narrowly focused, approaches.

Significantly, there are many linkages among the objectives in the four problem areas and among the actions that might be taken to achieve these objectives. Solving problems in four areas at once does not require a four-fold increase in the cost or number of actions. Most actions that are taken to meet program objectives, if carefully developed and implemented, will make simultaneous improvements in two, three, or even four problem areas.

What kinds of actions can be taken to solve problems in the Bay-Delta system? The actions can be grouped into categories of levee system improvements, water quality improvements, ecosystem restoration, water use efficiency, water transfers, watershed management, water storage, and Delta conveyance modifications. Specific actions range from physical restoration of habitat in the Delta to water conservation measures. Descriptions of the Program's strategies for solving problems by implementing these actions are presented in Chapter 3 of this document. More detailed descriptions for the first stage of implementation are presented in Chapter 4. Complete descriptions of program elements are contained in other *Program Plan Appendices* to this *Final Programmatic EIS/EIR.*

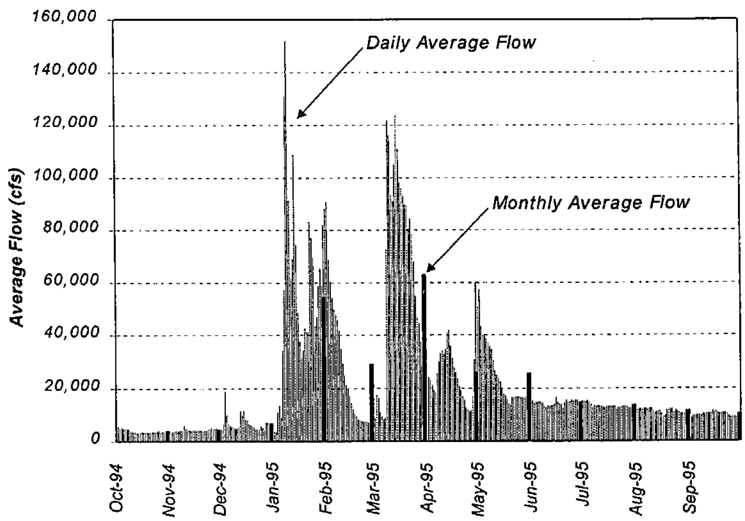
While CALFED generally does not expect to rely on new regulations to implement Program objectives, it does recognize that existing regulatory programs will continue to be implemented by CALFED agencies. CALFED represents a unique opportunity to provide high-level coordination of these regulatory programs so that regulatory implementation works in furtherance of CALFED Program goals. The CALFED Bay-Delta Program specifically defines incentives and voluntary partnerships to implement many individual actions in the Program. Incentives allow stakeholders to participate in CALFED actions which may not have been economical to them without the incentives. Partnerships allow stakeholders and CALFED agencies to leverage their individual resources by teaming together to implement certain actions.

Some regulations, like those contained in the State and federal Endangered Species Acts (ESA) and Section 404 of the Clean Water Act, are ones that CALFED must satisfy as the Program is implemented. Many other regulatory actions can be made more effective and constructive as a result of CALFED actions. For example, water quality regulatory agencies are obligated to develop total maximum daily loads (TMDLs) for certain water quality constituents in the Bay-Delta system. CALFED efforts in monitoring and research will provide valuable information which will assist regulatory agencies in developing these TMDLs. CALFED incentive-based source control actions will help reduce the load of these and other pollutants. In this way, the CALFED Bay-Delta Program will help in meeting many ongoing regulatory requirements.

Variations in Supply and Demand

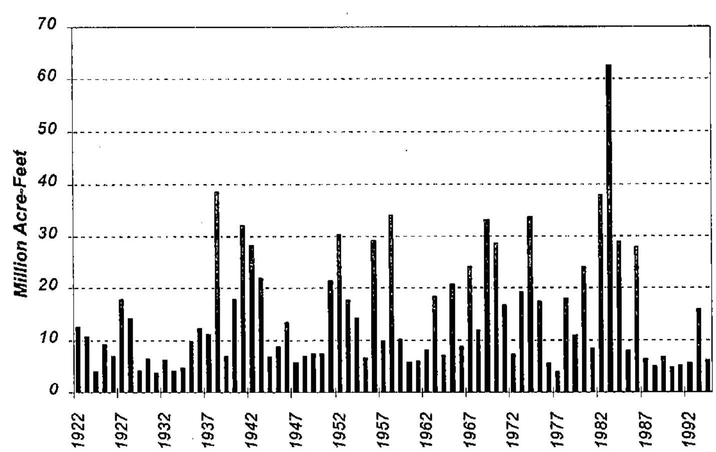
Any consideration of water management in California must start with a recognition of the immense variability in the availability of and demands for water. The watershed of the Bay-Delta system is subject to a highly variable rain and snowfall pattern. The total amount of precipitation and runoff in the watershed varies widely from month to month and from year to year. Year types are classified into five types from wet to critically dry, but even within each type there is considerable variation in the pattern of precipitation. Within any given year, whether wet or dry, most of the rain falls in the winter months, while snow pack typically melts in the late spring and early summer. In other months, water flow is typically much lower, leading to dramatically different flow levels for different months. Even within each month, flow can vary widely.

Sacramento River Flow at Hamilton City Water Year 1995



Two figures help illustrate the variability in the hydrologic system. Water flow variability is most notable when daily flows are examined. The first figure presents a graph of daily flows throughout a water year. For comparison, average monthly flows are also shown (thicker black bars). The average monthly flows mask the much greater variation exhibited in daily flows that rise and fall with the passing of each major storm system. It is quite typical for winter and spring storms to produce periodic peaks in flow such as those shown in January, March, and May.

Yearly Total Delta Outlfow



The second figure shows a simulated yearly total Delta outflow for the period from 1922 to 1994. The simulated Delta outflow is based on historical hydrology, but with existing storage and conveyance facilities in place and operating to meet system-wide 1995 level of demand. The graph reflects the average annual variability that occurs from year to year. Memorable extremes, such as the drought of 1976-77, are quite apparent.

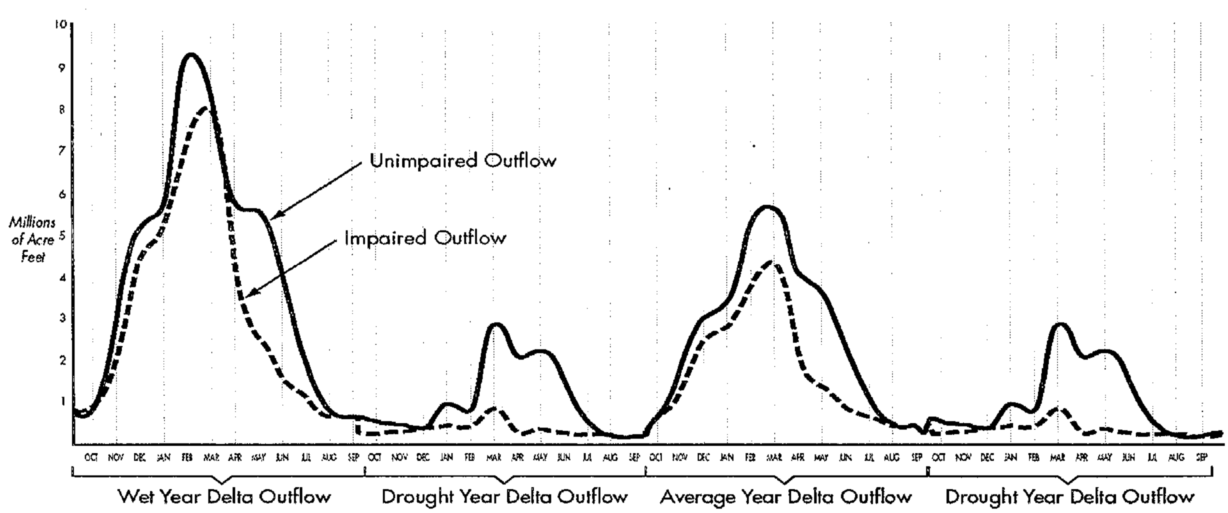
The demand for water also varies over time. Agricultural demands tend to be higher than average in dry years, because there is less precipitation available and plants need more irrigation. In addition, local surface supplies may be more limited in dry years, which imposes further demands on local groundwater and on water imported from elsewhere in the system. Agricultural water demand also varies substantially seasonally; the demand is highest in the summer, when natural flows are lowest.

Urban demands for water vary as well. Many urban areas experience substantial seasonal variation in demands for landscaping irrigation. In addition, urban areas dependent on the Bay-Delta for some or all of their drinking water supply place a significant premium on the quality of water (in addition to the quantity). In dry years and in dry seasons, increased salinity in the Bay-Delta (from both saltwater intrusion and upstream discharges), reduces the usefulness of Bay-Delta water to urban users.

The value of water in the ecosystem varies over time. For example, high flows in the early spring have substantial ecosystem benefits, including maintaining river and stream channels and triggering behavioral changes in some species, such as anadromous fish, that have evolved in this variable system. Ecosystem water needs are generally more consistent with the natural seasonal flow pattern than consumptive water demand, but historic changes in the system have resulted in circumstances where existing flows are low during times of high ecosystem need.

Variation in ecosystem demands for water is highlighted in the figure, below, which illustrates the simulated impact of the water diversion system on natural flow patterns.

Change in Delta Outflow from System Development



This figure suggests that water diversions have had a relatively higher impact on the natural flow regime in drier water years than in wetter water years. As discussed below, many of the recent environmental protections in the Bay-Delta system have tried to reduce this relative stress on the environment during drier years. This discussion of the wide variability of both the supply of and demand for water suggests one important water management conclusion; averages don't tell the whole story.

Averages are misleading because they mask the variability in flows and demands. An increase in Delta outflow in an average year may have only a minor beneficial effect on the environmental health of the system, whereas a similar increase in a dry or critically dry period may yield much greater environmental benefits. Similarly, although average increases in supplies may be desirable for urban and agricultural users, dry and critical year supplies are substantially more important given the higher demand and reduced alternatives. This variation in water supply and demand results in conflicts over water in the state, and conflict increases substantially in dry and critical years when all water uses, both environmental and consumptive, demand more water.

Institutional and Operational Framework

In response to the substantial variations in hydrology and in water demands, California has developed an extremely elaborate water diversion, storage, and delivery system. The broad purpose of this system has been to collect water in times of availability and to deliver it at the time and place of need.

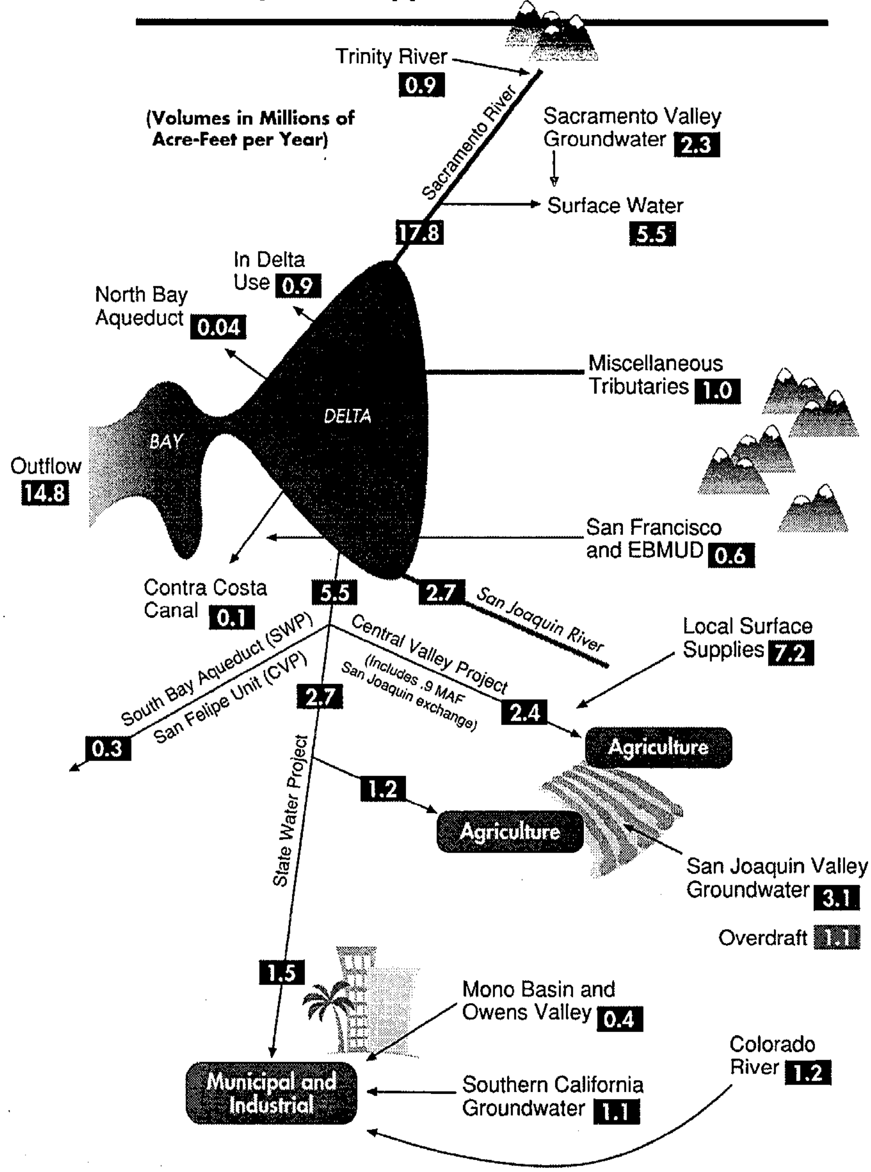
In addition to the physical water system infrastructure, California has also created a legal/management structure governing its water resources. This legal/management structure relies on a complex set of rights, regulations, and contractual relationships that define which water users (both consumptive and environmental) will have access to water at particular times. For consumptive users, this system relies heavily on the doctrine of prior appropriation -- those water users with more senior rights generally have more reliable water supplies than those with more junior rights.

In addition to allocating shortages, the legal/management system also has the effect of allocating water savings. For example, if an upstream diverter introduces some water saving management techniques, the next downstream diverter with senior rights may have an opportunity to access additional water, depending on water conditions. (More information on this point can be found in Section 2 of the *Water Transfer Program Plan* Appendix). Sometimes the allocation of savings is more complicated. In the State Water Project, water savings by one project user (Southern California urban users, for example) go back to the Project and are allocated by contractual rights to the next contractual project user (Kern County, for example). Finally, the California constitution, the Public Trust Doctrine, and common law principles govern how water can be used.

The following two figures illustrate a simplified view of water use in (1) an average year, and (2) in a dry year.

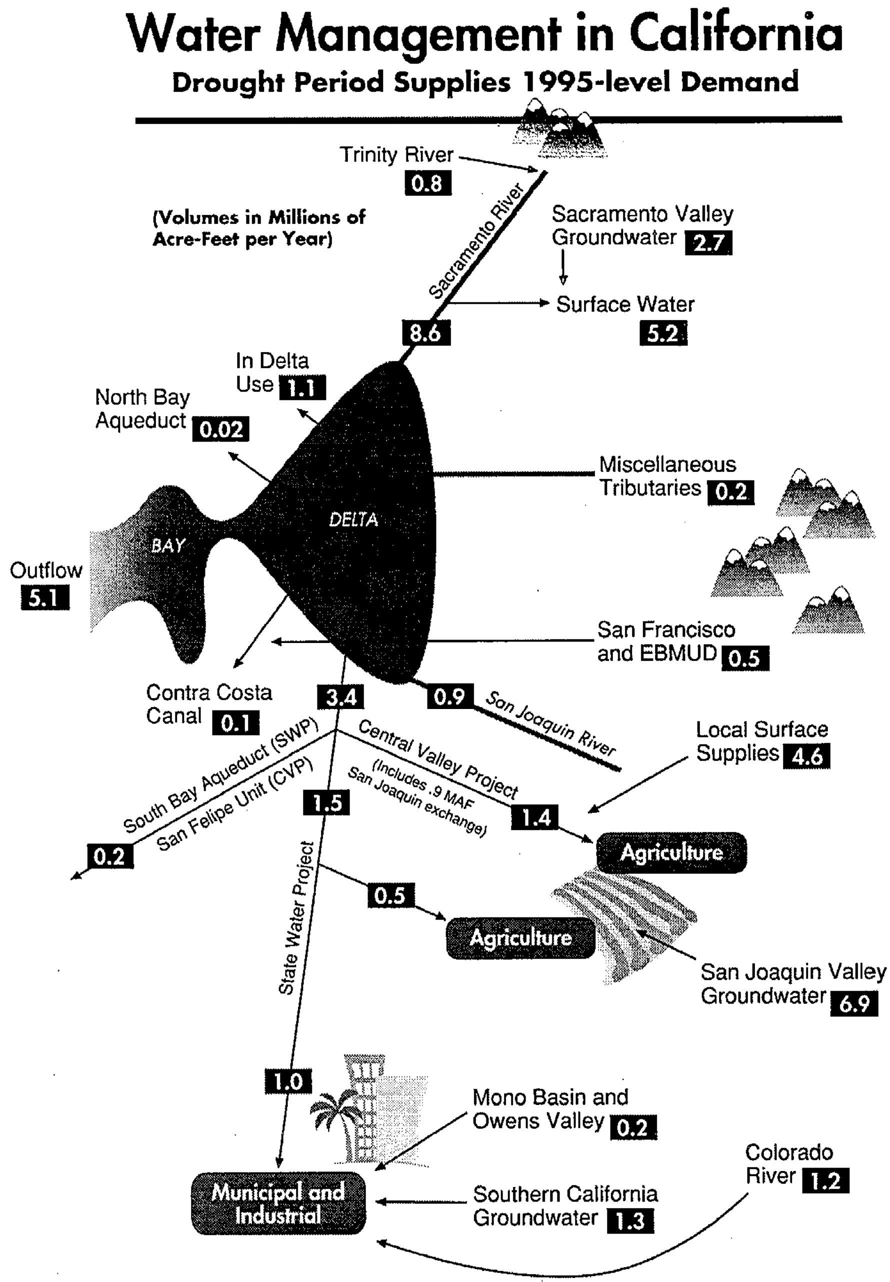
Water Management in California

Long Term Supplies 1995-level Demand



Two aspects of these figures are worth highlighting. First, Delta water use **throughout** the system is substantially lower during the simulated dry year period. This is true for urban and agricultural users which experience water shortages and shift to other sources to meet their demand. It is also true for the environmental uses (as represented by the decreased Delta outflow) because there is simply less water in the system.

Second, the figures show clearly an ongoing problem with groundwater overdraft in the San Joaquin Valley. This is especially true in the dry year scenario, where groundwater pumping has been used to make up for significant shortfalls of imported water. The problem of groundwater overdraft is critical to long term water management in California. Overdraft can cause land subsidence, deterioration of water quality, and increases in groundwater pumping. In addition, concerns about groundwater depletion and degradation are frequently voiced in the debate over water transfers in the State. While many western states have begun to take a coordinated water management approach that includes active management of groundwater resources, California has not. Long-term effective groundwater management throughout California will be essential to the success of a range of CALFED programs. The current lack of comprehensive groundwater management will limit CALFED's ability to improve water management in California, and will hamper efforts to carry out programs such as groundwater banking, conjunctive use, and water transfers. Groundwater management in California is an institutional challenge that has not yet been fully addressed.



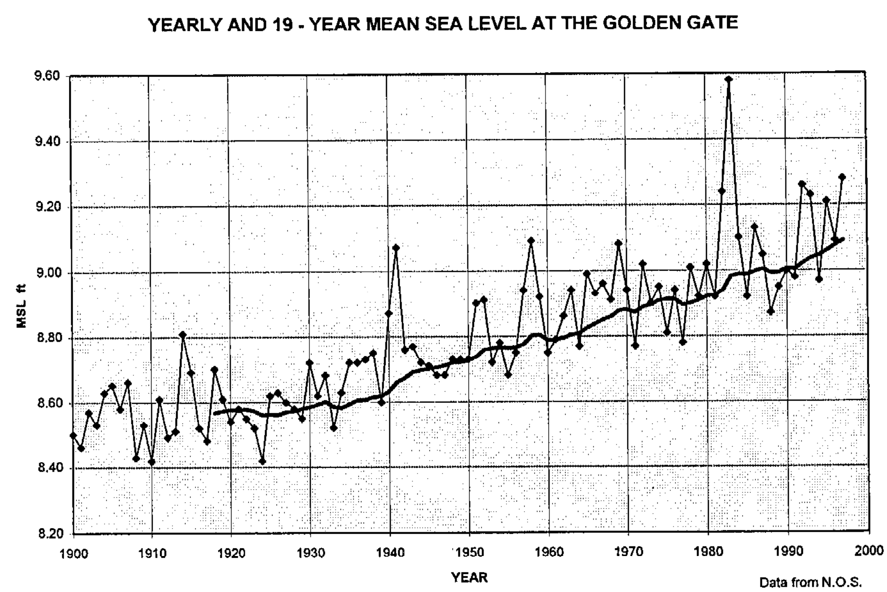
The preceding discussion of the hydrological and institutional framework of California water management is useful in understanding the current conflicts over water resources in the State. In recent years, the water management system has experienced increasing stress as the regulatory process has started addressing the environmental degradation evident in the Bay-Delta system. In effect, these regulatory measures have increased Delta outflow and reduced diversions, forcing consumptive water users to place more reliance on other sources (groundwater pumping, water transfers, etc.) Given that the last several years have generally been wet water years, the impacts of these environmental measures have generally been muted. These recent changes (Endangered Species Act protections, the Central Valley Project Improvement Act, etc.) in the regulatory regime will reduce water deliveries by the State and federal water projects in the driest of water years and generally indicate reduced operational flexibility.

Conflicts over water in the state intensify in the driest water years, when all uses, both environmental and consumptive, are competing for a drastically reduced natural water supply. In addition, the regulatory regime itself has had another effect. Protecting environmental uses through regulatory constraints has restricted the use of the water delivery system at certain times and has reduced the capability of the system to respond to consumptive user needs.

Adaptive Management

A third fundamental concept of the Program is adaptive management.

No long-term plan for management of a system as complex as the Bay-Delta can predict exactly how the system will respond to Program efforts or foresee events such as earthquakes, climate change, or the introduction of new species to the system.



The possibility of sea level changes induced by global warming or by other long-term climate trends is a good example of the need for an adaptive management approach to CALFED issues. Rising sea levels could have significant adverse impacts on the Delta system (including habitat, water supply, and Delta agriculture). Higher sea levels would increase salinity levels throughout the Delta, impeding habitat restoration projects in the Delta and dramatically reducing the value of water exported from the Delta for urban or agricultural uses. Similarly, long-term changes in temperatures could result in more variability in precipitation and runoff from year to year and season to season. Higher flooding could become more common, and drought periods could become more frequent. Some estimates indicate that California will experience an increase in winter runoff and a decrease in spring and summer runoff, with a resultant decrease in water supply reliability in the Central Valley basin. Given the high level of uncertainty over the direction and magnitude of climate change effects on Bay-Delta hydrological resources, adaptive management is essential.

The fundamental concept of adaptive management is that management prescriptions will be assessed and refined (adapted) according to new information in order to meet program goals and objectives. Adaptive management is an iterative process that involves: (1) identifying clear goals and objectives for the program elements; (2) using models to display our understanding of the

Bay-Delta system and to assess and prioritize a range of potential actions to improve the system; (3) implementing actions and research most likely to achieve goals and objectives and to improve our knowledge of the system; (4) monitoring and assessment of actions to gain information to refine the models and alter future actions in order to meet program goals and objectives; and (5) changing management activities based upon new information.

Adaptive management, as an essential program concept, acknowledges the need to constantly monitor the system and adapt the actions to restore ecological health and improve water management. These adaptations will be necessary as conditions change and as CALFED learns more about the system and how it responds. The Program's objectives will remain fixed over time, but actions can and should be adjusted to assure that the solution is durable.

The concept of adaptive management is an essential part of every CALFED Program element, as well. In every part of the Program, new or more intensive actions are proposed. Along with these proposed actions comes uncertainty. What actions work best to achieve program objectives? How can these actions be modified to work better, cost less, or be simpler to implement? How should the emphasis among actions change over time? Are there new or different actions that should complement or replace those that are being implemented? An adaptive management approach helps to answer these questions and allows CALFED to act upon those answers.

More detailed concepts of an adaptive management approach are included in the implementation plan in Chapter 4.